Oral History of Brian Hollins

Interviewed by:
David Laws

Recorded: November 4, 2014
Mountain View, California

CHM Reference number: X7284.2015

David Laws: Today is November the fourth, 2014. We're at the Computer History Museum in Mountain View, California. I'm David Laws, semiconductor curator at the museum. Today, we're going to record an oral history with Brian Hollins.

Brian spent many years in Silicon Valley on the manufacturing side of the semiconductor industry. I'd like to get insight into different aspects of his background and collect information on the state of the industry at various points in his career. So welcome, Brian. Thank you for joining us to today.

Brian Hollins: My pleasure.

Laws: Perhaps we could start out with a little bit about your background, your family. Where were you born? What were the major influences on your choice of career?

Hollins: I'm originally from Britain. I was brought up in Liverpool from a very early age. That's a northwest city, which was made famous a few years later by four certain musicians. I went to school in Liverpool, and I went to a secondary technical school, which did all of the usual subjects-- math, history, English, geography, et cetera. But it also included some artisan-type courses, like woodwork, metalwork, engineering drawing, that kind of thing. And I actually found that I enjoy that.

They were very hands on. In woodwork, for example, we would learn how to make dovetail joints. And in metalwork, we would weld things together. And I found I really liked that, and so that might have been my first step towards becoming an engineer.

Laws: How about your family? Were there engineers in the family anywhere?

Hollins: I had an uncle, actually, who owned a small neighborhood radio and TV service shop. And we would spend some time together, and he showed me how to build some simple little circuits. The first one, for example, was very simple. It was a cat's whisker radio. And he showed me how to build a little transmitter, for example, and I really enjoyed that. And I think that was my first step towards getting into electronics.

Laws: How about your mum and dad? Were they technically inclined?

Hollins: No. My mum was a housewife-- three kids and she was a Liverpudlian. My dad was actually from Wales, and he started off being a bricklayer-- very hands on. And he subsequently went into construction,

became a manager at a construction company. And he ended up being the Clerk of Works of Swindon [County] in southern England. The Clerk of Works is basically an inspector of public buildings.

Laws: Sure. And at what point in your school career did you start to specialize in math or sciences?

Hollins: Well, that would probably be at age 16. In Britain, the examinations were called GCEs, General Certificates of Education, I believe. And so, there's a GCE level taken at 16, and up to that point, you just took lots of different subjects.

And then, for the next final two years before college, you specialized. And I took Physics and Mathematics and Theoretical Mechanics. And you needed three A [Advanced] levels to get into university.

Laws: And where did you go to university?

Hollins: I went to Leeds. Leeds University is a northern university in Yorkshire. And because of my interest in electronics, I took a bachelor's in double-E.

Laws: That was pretty unusual at the time. There weren't many EE courses around the country, as I remember.

Hollins: There weren't many universities at the time, either, if you remember. And you're right. I can't remember, but there were probably just a handful of universities that offered double-E then. And so I did that. I started in '58, and I graduated in '61.

Laws: Was there any semiconductor content in those days?

Hollins: We took transistor theory at college, so I guess they existed.

Laws: I think I studied a diode when I did my physics degree. That was about as far as we got.

Hollins: You must be older than me, then.

Laws: And so you graduated in '61?

Hollins: 1961, that's right.

Laws: And what kind of companies did you look for? What were the opportunities back in those days?

Hollins: Well, I was anxious to get out of Liverpool, and so I looked down south. And London, of course, was the big magnet. So I looked down in London, and I ended up going-- and I don't know if you remember it, but in those days, the economy was starting to improve. Britain was just about getting over its postwar problems-- physical problems, being bombed, et cetera.

The economy was taking off, and it was just very easy for an engineer to get a job. Every graduating engineer in my class probably got at least two or three job offers, so he had a choice. So I chose a company called EMI Electronics. They were just outside of West London, in fact very close to Heathrow Airport.

Laws: In Hayes.

Hollins: Hayes, Middlesex, right. They also had a plant in Feltham, which was just a few miles south, and I spent time in each of those.

Laws: What kind of projects were you working on? Let me just fill in here. EMI is Electrical and Musical Industries,

Hollins: That's correct.

Hollins: And I think they made most of their money on the musical side. They owned Capitol Records. I think it was Capitol.

Laws: It was Capitol.

Hollins: And they were the ones who signed up the Beatles. I was in the electronics division, and I was there probably for about four and a half years or so. And I spent some time in a computer group designing logic circuits with transistors. This is before ICs became prevalent.

And I spent some time in a military electronics group, and we were designing circuits for military systems-- fuzes. I remember I spent quite a bit of time on a fuze, which is a circuit that you have in a shell or a missile, and it detects when you're close to the target and sends a signal to the warhead, saying -- ['Pow']

so that's basically it. And you know, I was an OK designer, but not a great designer. I really found my calling later on.

Laws: So that was about seven or eight years then, you were there?

Hollins: Yeah, that was about-- no, about four and 1/2 years.

Laws: Four and 1/2 years?

Hollins: Yeah.

Laws: And what stimulated your opportunity to come to America?

Hollins: Well, that was kind of interesting. That was a situation where-- it was one of those situations where, had I not have done this, then that, which is completely different, wouldn't have happened. And so what happened was that I was looking for work not in America, but in Germany.

It sounds a bit odd, but I got this idea in my head that I wanted to learn a language fluently, and the language that I had taken in my secondary technical school in Liverpool was German. So I started looking for a job in Germany. So every week, I would get the Sunday Observer, and they had a big international jobs page. I was looking for a job in Germany.

And then suddenly, I saw this great ad. It said, "We need engineers. Come and work in sunny California." And I was single at the time, and that kind of caught my eye. So I applied for the interview, and I found out the company was called Fairchild Semiconductor. And the two guys coming to conduct the interview were Pierre Lamond and Jim Diller, two very familiar names.

So I went to the interview, and I must have done the right thing because-- oh, I know what I did, which perhaps influenced it. I'd been told that Jim Diller was the plant manager of the diode plant. So I went along to the interview with a question pre-prepared about diodes, and it was a difficult question to answer. It was a question about how do you use a diode in a situation which is in between where it's been specified on the data sheet.

Laws: Which every engineer does anyway.

Hollins: Right. Well, they do, of course. And so I laid that one on Jim, and he just said hey, you're talking to the wrong guy. I manage it. I'm not the engineer. So that was that, but I think maybe that made an impression. And also, Pierre asked me a great question. I remember this. He asked me if I worked on my own cars. When you think about it, he's looking for a hands-on engineer.

And it just so happened that a few months earlier, I'd bought an MC TC sports car. And while I was pushing it to see what it could do, I blew a big end-- main bearing in the engine. And so I'd just put the thing together again. Anyway, the bottom line is they offered me a job on the spot. And a few months later, I had my green card -- very easy to get them in those days. And I came over here, and that would be April 1966.

Laws: April of '66.

Hollins: Right.

Laws: Interesting time in Fairchild history.

Hollins: It was amazing, just incredible. And everybody needs an element of luck in their career, and mine was being there then.

Laws: And what was your first job with Fairchild?

Hollins: Well, when I got here, Pierre, who had told me that I'd be starting in an integrated circuit division, or group, said that he actually needed somebody in the discrete transistor group more urgently. So I wasn't too happy about that, but anyway, he put me in the NPN transistor group, and it turned out to be a great move for me because I was working for a guy called Maurice Chidlow a fellow Brit, coincidentally. But Maurice was just super. He would spend an hour a day with me.

Laws: Great mentor. I saw him over the years at AMD and other places.

Hollins: Fantastic man. If I had to choose a mentor, it was Maurice. So the end of each workday, he'd spend an hour with me, and he'd go through the process step by step by step, in great detail. And basically, the first six months or so, he just downloaded everything he knew. So that was really nice for me.

Laws: What was Maurice's job at the time? He was a product engineering manager, perhaps?

Hollins: He was process engineering manager of the NPN transistor [group].

Laws: That'll be in the building on Whisman Road, probably.

Hollins: Yes. And he worked for John Sentous at the time.

Laws: And so after you'd finished your training, what did you do on a daily basis?

Hollins: Well, the job was a combination of process and product engineering, so I would spend time in the fab [fabrication area], most the time. And the product engineering side not so much because it was transistors rather than circuits. So it was really quite intensive process engineering, working in the fab area. Specifying the operations, writing the specs, making sure that the operators are following them, and when there were problems, figuring out what they were.

Laws: And that's almost a chemical engineering job, as much as it is electrical engineering.

Hollins: Well, you know, I loved process engineering and that particular job because it did involve all of these things. It involved understanding the physics of the devices, and there's some chemistry there, optics, photo-masking. So it was a real mix of disciplines. You kind of had to be a jack of all trades to be good at it.

Laws: This was at a period of time where Fairchild was really peaking out in terms of its creativity and its growth. Were you aware of any of the corporate machinations that were going on in those days?

Hollins: To be honest, no, I was not. No, it hadn't filtered down to me. And as a matter of fact, Bob Noyce was the general manager I think, right? Or vice-president?

Laws: He was vice-president at that point.

Hollins: He was vice-president. I was there with Fairchild for two and 1/2 years. I never saw Bob Noyce once.

Laws: So [Charlie] Sporck would've been general manager in those days.

Hollins: Sporck was general manager, [as he was responsible for] all of the groups so I would have reported to him eventually. And I saw Charlie a couple of times. But no, we didn't really know what the

hell was going on. In fact, the day that Charlie Sporck left, which was just about a year after I started, he went around to everybody, shaking hands with everybody. He went around throughout the Whisman Road plant.

And I was in a conference room with my boss at the time. And actually, my boss at the time then was Dave Heck. He took over from John Sentous. And Charlie walked in to say farewell to everybody. And Dave Heck shook his hand and said to him, Charlie, why? Charlie gave him a strange look, just walked out.

Laws: Interesting.

Hollins: So I guess Dave Heck didn't know who was going on either.

Laws: Right. Then, you moved on to the custom digital IC- operation

Hollins: I did.

Hollins: As I mentioned, Pierre had told me I could work in an IC, as opposed to a discrete group, and so I kind of lobbied to get back, and I transferred in after a year into that group. And there, I was working for Joe Rizzi. And Joe Rizzi was working for John Carey. So John ran this. It was called a custom IC group. They had a proprietary group and a custom group. And so there, I continued doing process engineering, but I also did a lot more product engineering. Back in those days, the engineers did both process and product, and they're kind of different disciplines.

And later on-- and certainly at National-- the two disciplines were separated out and engineers were typically process or product. But it was really a good thing for me. Two and 1/2 years at Fairchild-- that whole thing was a great training experience. And so, because the engineers were doing both tasks-- process and product-- I got this very broad exposure to the whole manufacturing picture.

Laws: What size wafers were you working on in those days? Two inch?

Hollins: I think we were an inch and 1/2 when I started, It might have been two inch in the custom IC group. I'd say it was inch and 1/2 in discretes.

Laws: And minimum dimensions would have been 10 microns?

Hollins: The minimum feature size?

Laws: I guess. Feature size.

Hollins: Well, actually, it's kind of surprising that we had to -- even in the NPN group, which made just a transistor, we had a mask, contact mask, with a 2/10 cutout, and that's 5 microns. That's pretty darn small for back then. We're talking about 1966.

Laws: And this was all contact printing.

Hollins: Yeah, it was contact printing.

Laws: And how many layers?

Hollins: The transistors were four layers. The ICs six layers. And metallization was the final, sixth mask. And they didn't have protective passivation at that stage.

Laws: That's right. That came later, didn't it?

Hollins: Came later.

Laws: Vapox and the other stuff.

Hollins: Exactly.

Laws: Do you remember any of the products you were working on? DTL? Possibly CTL?

Hollins: Well, you know, I remember in NPNs, transistor-- 1243 to 1250. But in the custom IC, I don't remember the product names. There were custom circuits that were built for OEMs and big companies, as opposed to the other group who did RTL and DTL logic and things like that-- CML logic, that kind of thing. But we were doing custom circuits, and I don't remember the product names.

Laws: And you stayed at Fairchild couple of years, two and 1/2 years?

Hollins: Two and 1/2 years, that's right. And what happened there was that there was a guy called Roger Smullen, another familiar name in the industry. He was one of the management team that Charlie took out of Fairchild when he went over to National. I had a call from Roger, and he was setting up a brand new linear fab area over there, and he wanted a supervising engineer, so he offered me the job.

It was a promotion. It was a chance to join not quite a startup, because they were fairly well established then. They had a few hundred employees-- but very young company, very dynamic. So how could I not? So I went, and that would be 1968-- late in '68.

Laws: And they were located in Santa Clara or Sunnyvale?

Hollins: They were in Santa Clara, and they were on San Ysidro Way, which is just off Kifer. Close to Lawrence Expressway.

Laws: Was there any significant difference in cultures in things between established Fairchild and semi-startup National?

Hollins: I don't think so. Fairchild was pretty dynamic too, so it was quite similar. The main difference, I think, was that there were clearer and shorter lines of communication to top management. And so people like myself coming in at a fairly low level found out very quickly what was going on across the board, so that was enlightening.

Laws: Was the move to linear challenging at all? Now that you did have to worry about circuits and how they work.

Hollins: It was challenging, yes. There was an existing linear product line [and] wafer fab area. In fact, it predated Charlie Sporck, and was set up by Dave Talbert and Bob Widlar. They were this brilliant linear duo who started off at Fairchild. And I think everybody knows that Widlar was this genius guy who created all kinds of amazing firsts in terms of linear monolithic circuits. And Dave Talbert was the process guy who supported him.

They had left Fairchild-- I think about a year before Charlie left. And they worked for a subsidiary of National Semiconductor [founded as Molectro in 1962], and then Charlie went over there and took over National. So the linear group existed, and it was Talbert and Widlar. And they had gotten to the point where they were very successful.

They had a whole string of successful products for National. And it had reached the point where some of their circuits were becoming so popular that there was a big demand for volume. But Dave Talbert did not want to expand his line beyond one shift. He wanted to keep it as a development line. And so knowing Dave Talbert, he probably just refused to expand. Sorry, Charlie. I'm not going to do it.

And so they set up a separate line, which they called the Standard Linear [SLIC] group, and that was the one I was hired into as a process engineering manager. They set that up in order to pick up the volume products from the existing linear line that was called LIC at the time. It was re-branded ALIC, Advanced Linear, later. So I worked with Roger, setting up this new fab area, and-- great experience too. I wrote all of the process specs for that line.

Laws: Were involved in selecting equipment?

Hollins: Yes, I was. And a lot-- in terms of that particular fab area, a lot of those decisions had already been made, but I helped make some of the final equipment decisions. And then, in subsequent fab areas, I was involved in selecting all of the equipment. Actually, over my career, which is relatively short in retrospect, but it was about 24 years or something like that. Over that time frame, I worked in eight different fab areas and set up five of them.

Laws: What an experience there. What is a day in the life of a supervising engineer at National in 1968?

Hollins: Well, as I say, we're responsible for setting up the process. And I would have one, or two, or three engineers working for me, and so the process responsibilities would be divvied up between these guys. We'd have one or two technicians working for us.

And so we would write the specs for the process, and we would supervise it to the extent-- we wouldn't supervise the line workers, the fab workers. That was the job of the foreman and general foreman. But we would police it, basically, and make sure that it's being done correctly. And if there's any additional processes needed, we would develop them. And that's basically it.

Laws: These were the days when there were still quite violent fluctuations in yield and problems where you couldn't make something for weeks at a time, sometimes. How would you go about analyzing and fixing problems like that?

Hollins: Yeah, those were interesting days. And you're right. It happened more often than we would have preferred, but that's the way it was, and especially in linear. It's more difficult to make, in many ways, a linear circuit than a digital circuit. And so we had some real doozies of problems.

I don't know that we were ever down for many weeks. We were certainly down for maybe a couple of weeks, but when you've got a production line going, that's a major major problem. But what would happen, usually, is that something would suddenly crop up, just out of the blue.

And one example, for example, in National, it was something called P-film, or phantom P-layer some call it. And what happened was that this phantom P-layer would appear on top of the buried collector region, underneath the NPN transistor that's diffused into the epi-region. And instead of having an NPN, you'd have an NPNPN, and it would just totally destroy the characteristics of the transistor.

Laws: A Shockley diode?

Hollins: Well, certainly a multi-diode situation. And so that would mess things up. And this was a mysterious problem that-- it was in the process basically that we picked up from Dave Talbert. We set up Dave Talbert's process in the SLIC group. And it was like a virus, I guess. It transferred with the process. And he actually helped us out from time to time, David-- good guy to work with.

And it was a very sporadic problem-- appear [then] go away. And it would be on some of the wafers, but not all of the wafers. Within a wafer, it would be on some of the chips and not on other chips. And so, I mean it was really quite mysterious, and it took us quite a time to find it.

And what typically happened was that you'd shut the fab down. Every day, the engineers would get together. We'd brainstorm what might it be. It might be this. It might be that. And then, you'd put together test runs, split runs that would go through and test each thing. And then, at the end of the day, you'd get together, and you'd go over the results of all of the runs that you'd done.

So what would happen is that you would have production workers sitting around looking for work. The line's shut down. You'd have engineers generating a lot of engineering runs so that they would be whistled through very, very quickly. And so we got feedback pretty fast.

Laws: Basically, you'd be running wafers with slightly different process parameters--

Hollins: Right. Well, I mean, if we suspected a clean, we'd do a split run. And some of the wafers would go through the standard clean, and some of them would go through a different clean. Then, we'd compare the results, that kind of thing. And we ended up solving all of the problems, but there were quite a few.

Laws: This is where the background in chemistry, physics, and optics is all extremely important.

Hollins: Yeah, and that particular problem was a chemistry problem. And it turned out that one of the sources that we used-- the antimony trioxide source that we used for collector pre-dep [deposition]-- it said right there on the bottle, 99% pure. That's 1% impurities-- we never knew what they were. The vendor couldn't tell us what the impurities were. We didn't have the analytical tools back in those days to be able to measure it, so we had to surmise it.

And we surmised it was a fast-diffusing p-type contaminant, and we think it came from that particular source. It was within the source. And it could have been boron. It could have been aluminum, could have been gallium. These are the three most common p-type dopants. And we never did find out which one it was, but we did come up with a couple of solutions that prevented it from happening going forward.

Laws: So you did this for a couple years?

Hollins: Yeah, probably about 18 months, 2 years. And then, I was promoted to run a new product line, and I moved over to digital. The company had decided to get into the DTL business. And they second sourced TI's T-squared line, so they had this big T-squared business going on in parallel with the linear.

And so they decided to [get into] DTL, and I think it was the Fairchild [930] line that they second sourced. So my job was to set up a new fab area, staff it, and produce all of these second source devices.

Laws: What would a fab area have consisted of in those days? Still contact printing?

Hollins: Yeah. In the diffusion area, you've got, obviously, pre-dep furnaces-- diffusion furnaces-- epitaxial reactor, the masking area and its photo-resist deposition, align and expose-- and that was using contact masks at that time, which means that the mask itself was in contact with the wafer. And we got away from that later on for yield reasons. And the deposition systems-- vapox, silox, that kind of thing.

Laws: Typically, physically, how big-- how many square feet would have been in a fab area?

Hollins: They got a little bigger, obviously, as volumes increased, and subsequent fab areas were larger. But the early ones were probably around maybe 5,000 square feet. And then after that, they were maybe 10,000 square feet.

Laws: And this was a two-inch wafer line at that time?

Hollins: I'm trying to remember--

Laws: It was about the transition to three-inch?

Hollins: Two to three, yeah. I ended up going back to linear later, and we built a new wafer fab area in Building C, that big, grey monolith [on Kifer Road, Santa Clara]. And that was three inch. That, I remember. Now, the DTL might have been two. It might have been three. I can't remember.

Laws: And the minimum feature sizes?

Hollins: Again, five microns? Linear is just not a feature-size driven technology. It's not necessary in linear because of the high voltage devices and deeper junctions. And linear circuits sell not based on being able to cram more transistors into it, but based on the wizardry and the sophistry that's designed into the chip.

Laws: You had P&L responsibility for this?

Hollins: Yeah, that's where I picked up P&L responsibility for the first time. The job was called product line manager. So, for example, I'd have a process engineering manager who worked for me, a product engineering manager, test engineering manager, a general foreman whose foremen supervised the line workers. And I also picked up an assembly line that was added to my function. The assembly line was for the whole company. It was a hermetic assembly that they used. They did military assembly.

Laws: These were the ceramic Dual-in-Line packages?

Hollins: Cer-DIPs, TO - 3s, flatpacks. And they also gave me-- shortly after this, I remember Talbert and Widlar quit. They retired. Widlar went down to Mexico. Talbert, I think, went down to Paso Robles. And that was it. They were out of the business after then, although Widlar came back on a contract basis later for both National and for Linear. But he always stayed domiciled in Puerto Vallarta.

So after they left, the company moved a guy called George Rutland into the PLM manager position for that linear group. They renamed it Advanced Linear. And so George was moved across from another digital group. It was called Digital Special Products, if I remember right, DSP. And that was a group that made all of the non-TTL, non-DTL stuff-- all of the high voltage, high speed digital type products. And so I inherited that too. So I was running DTLs and DSPs. I was running the assembly line.

I did that for a while, and then George was, I believe-- was sent to Singapore to run the Singapore plant. And at that point, I lobbied to get this job because that would take me back into linear. And the guy who was in charge of the linear group at that time was Jim Diller. So I meet Jim Diller again. He's one of the

guys who hired me-- 1966. And so I lobbied for that position, and they gave it to me, and I moved back. I was product line manager at ALIC, working for Jim. And that was a position I basically remained in for the balance of my National career.

Laws: And these were the Advanced Linear products, so you were working on new products, new processes?

Hollins: Yes, that's correct.

Laws: Anything particular you recall about the challenges you went through bringing up a new product?

Hollins: The design manager was, at that time-- after Widlar left-- was Bob Dobkin. Dobby was a protégé of Widlar's, and he was hired-- I think he joined maybe around 1969 or so. And so now, I'd be talking about maybe 1970, '71. So I was working with Dobby on the design side, and he was just a very, very creative guy, brilliant designer, one of the handful of world-class guys out there. And he had no problems coming out with new products.

And our job was to support him, so we had to continue giving him a basic process-- high voltage, low noise, high gain-- that he could use for the linear circuits. And if Bob wanted something-- an enhanced resistor, for example, or a better transistor, like a JFET transistor-- then we would come up with that. And it all went pretty smoothly.

Laws: Did he have to push very hard to get a new transistor? It's always a pain bringing one up and characterizing it.

Hollins: No. It would be more of a pain if it was a new process-- completely new process, as, for example, CMOS. CMOS was the popular digital process at the time. Linear wasn't using it, initially. It was all bipolar. Linear did eventually go to CMOS in order to enter certain market segments where clearly that was the better fit, process wise. So that would be a pain, but no, it was pretty straightforward. If it was individual things-- can you get me a better resistor, better JFET, that kind of thing, then we'd come up with it.

We learned a lot from reading in those days. We'd scour the literature. The technology was just exploding, and there was all kinds of research being done in all kinds of different companies, and they were being published all of the time. And so we stayed very close to the literature; IEEE transactions, electron device journals, that kind of thing. And so you get ideas about techniques coming up-- a better resistor, a better transistor or whatever.

Laws: Now, by now, you had how many people working for you in the advanced line?

Hollins: Oh, I haven't thought about that for quite a while. I probably-- in the process engineering group, I would have maybe six to eight people, similarly for the product and test engineering groups, maybe a half a dozen in each, so a whole team there. I'd have obviously a lot more people on the production side, the people who were making the circuits. And depending on how many shifts, there might have been 15 people on each of 3 shifts and the supervisor on top of that. So you know, it might have been 60 or 70 people, I think.

Laws: OK. What was hiring like in those days? Was it tough to find talented people? Did you have to do a--

Hollins: Not really, no.

Laws: --lot of training?

Hollins: No, no. As far as engineers were concerned, between “borrowing” people from other companies and new graduates becoming available each year for the junior engineers, it wasn't bad.

Laws: And you were in that role for how long?

Hollins: Well, I [was] in that role until I quit and went to Linear [Technology Corporation] So I was in that role for about-- I'd say from about 1971, '72 to '81, so about 10 years.

Laws: 10 years-- so the business must have grown substantially in that time because that was an important part of National's business, wasn't it?

Hollins: Yeah, it grew tremendously. And so by now-- in fact, by now, there was a third group added called Consumer Linear to address the consumer market. So we had the Advanced Linear group. We had the Standard Linear group. We had the Consumer Linear group. And they were pumping out lots of product that was very popular and fueled a lot of growth. And also, the digital side was also doing the same thing.

The company was growing very big. Now, I think by the time we left National, I think its linear business was well over $200 million. And it sort of was interesting too how the linear groups evolved. As each group was added, it kind of became independent. SLIC was started off to support the original linear group that would take the high volume products.

But Jim Diller hired a very competent design guy to run the SLIC design group, Jim Solomon. I think he came out of Motorola. So we had separate groups then. We had the original linear group with its own fab, its own design; SLIC, its own fab, its own design. And Jim Diller set up a third group, Consumer Linear, with its own fab, its own design group. And so each of them became independent, and then each of them started putting out their own products, and there were no transfers between them after that point.

Laws: Right. Now, did you ever have design working for you in that period?

Hollins: No. No, I didn't. I was always in manufacturing.

Laws: So Dobkin was a peer of yours then, and you both reported to Diller for a while?

Hollins: We both reported to Diller for a while, and then to Bob Swanson after he came in. That's right.

Laws: Was there much difference in style between Mr. Diller and Mr. Swanson?

Hollins: I'd say so. Yeah, I think Bob was more of a hard-charging guy, let's put it that way-- but two very, very competent guys.

Laws: Certainly. Both of them

Hollins: Extremely, and very successful guys.

Laws: Yeah. It's interesting how such different personalities and different styles can get the same results.

Hollins: Yeah. That's true.

Laws: Just a matter of how you use the skills you have and all the people-- choose the people to work for you. So you set up the first five-inch wafer area, I think you said?

Hollins: Yeah, that's right. It's kind of strange that the lowest volume linear group of the three-- and linear, not digital-- would set up the very first five-inch fab area, certainly in Silicon Valley, if not in the world.

Laws: Did they want a guinea pig—so they choose something small?

Hollins: Well, you know what? I think it was just a timing thing. We just happened to need another fab for capacity reasons. And it just so happened that the semiconductor equipment manufacturers were coming out with five-inch equipment right then.

And you know, it's just timing. If the digital people were setting up a new fab then, they would have gone five inch as well. But it just happened that we were the first. And not only ALIC, but also CLIC-- we set up two five-inch lines pretty well in parallel. I think we were just a little ahead-- ALIC-- a little ahead of Consumer Linear.

Laws: Was there much of a learning curve bringing out new equipment, new wafer supplies, new chemicals, probably?

Hollins: Well, there's always a learning curve, but it was not a major problem. We're getting close now to the time we left. So I didn't run that five-inch fab for very long before we actually left and went to Linear.

Laws: So tell me about the process of leaving. What was the factor that made you decide to leave?

Hollins: It was a combination of frustration, A; knowing we could do it, B; and wanting to do it, C, for potential financial reasons. Who doesn't want to get rich kind of thing if they have the opportunity? But the thing that really kicked it off was the frustration level with the way the company was going. It was getting very large.

The linear group was by far the highest profit-making group, I think, percentage wise. Hybrids might have been a little higher than us, but they were a much smaller group. So in terms of profit dollars, linear just dominated. And our money was being spent not on linear so much, but being spent on other things that didn't make any sense.

Laws: To you.

Hollins: I mean, National got into watches.

Laws: Cash registers, watches, computers, add-in memories.

Hollins: Calculators, memories, microprocessors. They got into the very fields where they could not be competitive when push came to shove and where cost was what made the difference between being profitable and not. Against the Asian manufacturers, it was just no contest.

So we didn't think that this made sense at all, so we-- and I know that Bob was getting frustrated with the management structure. National went towards a matrix management structure, which basically, under that structure, the buck doesn't stop at one desk. It's shared between two desks. And so it was very difficult to get decisions made. So he had a high level of frustration.

And we all shared adjacent cubicles in the linear group there, and so we would lean over the cubicle and chat to each other and share frustrations. And one of us said, well, [why] don't we do something ourselves? And it came to pass.

Laws: That would've been about 1980, '81?

Hollins: That was '81, yeah. 1981-- we left in July of '81 and incorporated in August of '81.

Laws: Was that an easy decision for you? Were there any qualms about leaving National?

Hollins: None at all. It was very easy, and I think it was very easy because I had such confidence in the other guys. Bob Swanson-- extremely good business guy. Dobkin-- it'll be hard to find anybody who could match his talents. And all of this was very clear, and I was a pretty good process guy, and we had the respect of each other.

Dobby and I used to work-- get along very, very well, and he knew he needed good process support, and he recognized in me that I was somebody who knew what they were doing in that field. And so we all-- I kind of just think that we just knew that each of us would do his job in the new company, and that's all it took because we were already a team.

And we also had a marketing guy, Brent Welling, who joined us, and he'd been the linear marketing guy reporting to Swanson for some years. And so we just had a complete team. In fact, we were called the dream team by the press when we left. That was kind of a bit of a high standard to live up to.

Laws: Sure. What was the process of setting up the company? You each took a piece of the action?

Hollins: Oh, in terms of stock ownership?

Laws: No, in terms of I'll do this, you do that.

Hollins: Oh, it was very clear. I was the manufacturing guy, so my job was to set up the wafer fab, set up the assembly line for in-house assembly, set up the test system for wafer test and final test and test and finish, all of those areas. That was my job. Your job is to make the part, so that was me. Dobkin's job was to hire bright design engineers and create circuits that hadn't been done before. That's the hard part. I mean, I thought my part was pretty straightforward. He had the hard part.

Laws: Yeah, you knew exactly what you had to do.

Hollins: Oh, I knew exactly what I had to do. Exactly. It was-- for me, it was an extrapolation of what I'd been doing. The process improvements-- after the pioneering processing, which happened way back in the late '50s, early '60s, they were the true process pioneers. These were the guys who-- the “Traitorous Eight” who founded Fairchild. They set up all of the original processes.

And not only that, but they were making their own equipment. We could go out by the time we did it and just go to an equipment manufacturer and order what we wanted. The original founders of Fairchild-- they were doing things like building their own crystal growers, for example, and making their own furnaces. They are the true pioneers.

I think after that, process improvement was more evolution, as opposed to revolution. So for me, I knew it was a matter of evolution. I could use the latest equipment. I can improve yields by using the latest equipment and just taking it from there.

Laws: Obviously, it takes time to set the fab area up. Did you use some outside wafer fabrication before you actually had your line running?

Hollins: We actually did because before we built our factory, we had a 1-year, maybe 15-month period where we were in leased offices on Bernardo-- actually, North Bernardo Avenue in Mountain View. And during that time, the designers were putting together a lot of mask sets for second source products. Our strategy was to go out initially with a line of second source products. We second sourced the popular National parts, popular PMI parts, Intersil parts. So we'd start off with those products, and then we would segue into our own products. That was the strategy, and that's exactly what happened.

But what we wanted to do when we got our fab area up and running-- we wanted to be up and running with mask sets that we already knew worked. And so what we did is run those mask sets through-- we found a small company in Florida-- West Palm Beach, I think it was-- called MCE Semiconductor, and they had a linear process. It wasn't a very good linear process, but they could make the devices to allow the designers to characterize them, check them out-- basically checking the mask sets out, and so we did that. We never used a foundry for production products.

Laws: So you were able to get the fab up and running in time to make the first production units?

Hollins: Yeah.

Laws: How long did that take?

Hollins: I think we had-- the first wafer we had out pretty quickly. We founded in August of '81, and I think the first wafer came off the line around the end of '82, and maybe early the next year-- very early '83. And then, we had to assemble them and ship them. And I think-- my recollection is somehow like 20 months after we were founded, we were shipping production units out the door.

Laws: And what kind of area was this? Five inch again?

Hollins: It was four inch.

Laws: Four inch? OK.

Hollins: Now, the five inch-- so you might say, well, why didn't you build the five-inch line because we'd already done that at National? It was because it cost a lot more money to buy the equipment to build five inch, and we wanted to conserve capital spending. And there's that factor, but there's also the factor that it would take us quite a while to build up to volume.

The five inch makes sense when you already have a volume organization, but we didn't. We're starting from scratch. And so we decided four inch made plenty of sense. That four-inch line-- our first four-inch line-- I think it took about seven years after we founded, so that would be more like five years after we started making wafers-- five and 1/2 years-- before it maxed out and before we had to put in a second fab area. So it was a very good decision, and it helped us become profitable at an earlier stage, which obviously helps IPO as well.

Laws: Were there any new equipment decisions to make in terms of equipping the line, knowing there was going to be something that might be important two years from now? You'd gone to projection aligners by now, I presume?

Hollins: No, we hadn't.

Laws: Still contact aligners?

Hollins: No, it wasn't contact. There was something-- there was an intermediary process technology called proximity align, and so we used Canon proximity aligners. And what that did was it held the wafer just slightly, not quite touching the mask. And so it got around the problems of generating defects with the contact. And it was perfectly acceptable in terms of feature size for what we wanted to do.

And again, feature size then was probably, the minimum feature size, around five microns. And it went down later on once we set up CMOS processes. But that was the right decision. It gave us [what we] wanted, saved us a lot of money.

Now later on, when the company decided to go into switch capacitance filters and D to A converters, we set up a CMOS process for that because that was by far the best technology. A CMOS transistor is a much better switch than an NPN or PNP bipolar transistor, and it made sense to go to CMOS.

Laws: Did you have to go out and find new process engineers to bring that process up?

Hollins: You know, we probably did hire somebody. I can't remember exactly, but I had a process engineering manager, Wadie Khadder, who I should certainly mention here because his contribution to National's and Linear's success was tremendous. He was just a superb process guy. And I hired him when I was at National to be my supervising engineer, and he had worked at PMI. PMI was a small kind of niche linear company. I think they might have even been founded before National or about the same time-- late '60s, I think?

Laws: —Guys from Fairchild founded PMI, didn't they?

Hollins: Yeah, Garth Wilson and Marv Rudin. And they had some very good designers. George Erdi was one of their designers, and he joined us very, very early on-- us meaning Linear-- very, very early on after we founded-- like days.

But I came across Wadie Khadder and just-- brilliant process guy, probably better than me. I didn't mind. So once I'd hired Wadie, he kind of took over [in processing]. He hired the process engineers. I think he probably did hire somebody with CMOS experience, and they developed the CMOS process. And the CMOS process, by the way, was optimized for linear needs.

Laws: Analog switches?

Hollins: It wasn't a low voltage digital-type CMOS. It had higher voltage capabilities, for example. We ended up with a number of CMOS processes-- high voltage, high speed.

Laws: So again, you would not have been pushing lithography there at all?

Hollins: Well, for the converter circuits and the filter circuits, then we pushed it down a bit lower. And they then utilized the steppers using the new technology, and so they would have gone down to smaller feature sizes.

Laws: So they bypassed projection alignment?

Hollins: What did you say, bypass? The CMOS? Yes, I think-- actually, we might have started with the proximity alignment, but we went to-- I think what happened is that we started with the proximity alignmers for CMOS, but then, when they went to bigger and bigger circuits, maybe around the 12-bit D-to-A die. That's when they brought in a stepper and used the projection method.

Laws: Dramatic difference in the cost of the equipment there.

Hollins: Very expensive, yeah, but we didn't need many steppers. We didn't need them for all of the operations, either. So we might have used-- probably used proximity for some of the layers and steppers for others. Although I think the company-- after I left, the company went more to steppers-- I think, when they set up their Camas factory, which I wasn't involved with.

Laws: That was Camas, Washington?

Hollins: Yes, Camas, Washington, just shortly after I left. I think they went to steppers across the board there. I may be wrong.

Laws: Remember roughly how much it cost to bring up your first fab line at Linear?

Hollins: The fab line itself?

Laws: Manufacturing.

Hollins: Certainly, in more global terms, I know that it cost us-- we raised about $17 million between the three private investment rounds that we had, plus a $9 million lease line. For that $17 million, we spent half of it on expenses and half of it on setting up the line, so that would give us around maybe $8 million to set up-- to do the whole thing-- not the building, but to put in all of the support work and set up the fab and set up the assembly and that-- $8 million. It was not very expensive.

Laws: And that would have probably got you to about a $100 million run rate.

Hollins: For the first fab, I think it probably took us close to that. Maybe $80 million?

Laws: That's an impressive return on the investment.

Hollins: Well, this is why we went into linear-- high-performance linear. As I mentioned earlier, customers pay for the content, not the cost.

Laws: Sure. How was the company structured then? There was yourself, running manufacturing. Dobkin was running design--

Hollins: Yeah, he was vice-president of engineering, right. And we had the vice-president of QA, QA&R. The company really stressed quality and reliability, big time, from day one. It was very, very important. We wanted to give customers a reason to come back to us. And in addition to performance, quality and reliability was very, very important in those days. This is following a period when the industry did a pretty poor job of delivering QA&R.

Laws: It's after the scare of the Japanese having so much better quality than the US manufacturers.

Hollins: Indeed. And it was an American OEM-- I think it was HP that first exposed that. They pointed out they were buying parts from American suppliers. They were buying them from Japanese suppliers. They compared the quality levels, and they published them, basically. And the American suppliers were shocked to see the difference. It was not even close. And so we really became religious after that, and indeed get caught up and maybe even surpassed them over time.

Laws: And so the VP of quality reported to the same person you did, to Swanson?

Hollins: To Bob Swanson, yeah. Quality was always considered to be at that level and independent. It had to be independent from manufacturing for obvious reasons.

Laws: What sort of issues did you have with trying to meet some of those quality demands that might have been unreasonable from a manufacturing perspective?

Hollins: One of the things we did was introduce statistical process control, and that went a long way towards bringing down the average outgoing quality levels. I think perhaps reliability might have been

more of a problem, but that's a little bit more difficult to pin down. So you might have parts that drift in the field, and we might find them out ourselves with an accelerated life test, or a customer may return them after being in his socket for a few years.

So it was probably trickier to solve those problems, but we did. We got them solved. We came up with a pretty well bulletproof process that was impervious to positive [ion] contamination from packaging, usually, especially plastic packaging. And we had multi-layer passivation that protected from positive [ion] contamination and also protected from moisture.

Laws: Was that something proprietary to Linear, something you developed, or fairly common in the industry?

Hollins: Well, when you say proprietary to Linear, I mentioned that we used to read the literature a lot. You could almost find everything that happened in companies. You can almost find them all if you scour the literature. So what we did-- you'd probably find papers that describe it, but the implementation of it and the optimization of it would be unique to each company.

And we also used implant techniques to make the surface of the silicon more resistant to negative charges that might accumulate on the surface. And again, you could find that, if you look for it, in the literature. In fact, a lot of patents have been invalidated when the patent owner goes after somebody and the people being accused will go out and come up with, hey, here's a paper that was published before your patent was submitted, essentially describing what you're doing. Like I say, we got a lot of ideas from the literature.

Laws: Are people still publishing that level of information? Or is considered much more confidential these days? I know you've been out for a while.

Hollins: David, I've been out of the business for 25 years, but I'd be very surprised if they're not because the industry just continues to mushroom.

Laws: Didn't National sue Linear over proprietary trade secrets or something of that nature?

Hollins: They did. They did, indeed, and I think also some patents later on. But yes, they did, and it was like a two-step lawsuit. They started off-- as soon as we left, they hit us with a trade secret lawsuit, which was a joke because they didn't even know what we were going to do at that point, so how could they accuse us of stealing trade secrets?

And so they eventually withdrew that, with the proviso that they could come after us again once they'd seen our products and, with the permission from the court that they can have a special master come in and take a look at how we were making them.

And that happened, and it turned out the special master was Roger Smullen. He sort of ran National's linear group. And so he came in, and he checked everything we did, and he came out-- this is kind of amusing. He came out with a list-- a list of National's linear trade secrets. And he actually went down all of them, looked at what we did, and he came up with a small handful of what he said, yes, they are doing what's on this list of yours.

And the reason why it was kind of hilarious is that when National's lawyer filed this list of trade secrets with the court, somebody in the court forgot to stamp proprietary information on it, and it was put out for public viewing.

Laws: So everybody knew National's list of trade secrets.

Hollins: Yeah, absolutely. It became public. And the first guy to publish it-- not the only guy, but-- actually, it might have been the only guy to publish the list-- but was Matt Hoefler.

Laws: Don Hoefler.

Hollins: Don Hoefler, there you go, of the famous Microelectronics News letter. It was a little gossip paper that this guy put out that everybody bought and devoured. He actually published the list, and all hell broke loose. National's lawyers threatened to sue him, blah, blah, blah. The San Jose Mercury also published[,]-- they didn't actually publish the list, but they published the fact that the list was available at the courthouse and all you had to do was go down there.

Laws: Right. It was in the public domain now.

Hollins: And National forced them to backtrack. And they tried to get them-- they tried to get Hoefler to go out and get back all of the copies of his sheet that he'd sent out. That was ridiculous. But anyway, the bottom line from that was that there were some items on it that apparently we were doing that National claimed was a trade secret-- almost unavoidable, actually.

And so they slapped another trade secret lawsuit on us, for the second time, and that one lasted quite a long time before it was resolved. It was actually resolved in a settlement before it went to trial-- shortly before it went to trial. So it was settled.

Laws: So it wasn't something you had to redesign to get around or something. It was easier to settle than to--

Hollins: [No we didn't.] We gave them a certain amount of money, which didn't even cover their legal costs, and I think there were some agreements made about sharing patents and that kind of thing. I never saw the details of the settlement, but it was amicable, and it worked out well for us, and we continued on. All of this time and effort spent-- and money-- spent by National was just basically wasted.

Laws: Did you spend much time with the lawyers?

Hollins: I did. I spent a fair amount of time, yeah. But we were young. We could do more than one thing at the same time. It didn't slow us down at all.

Laws: You worked with Wilson Sonsini, on that?

Hollins: Wilson Sonsini, yeah. They represented us. Brown and Bain I think, represented National. And we had-- the Wilson Sonsini guy's name was Mike Ladra He was the attorney who took care of it for us.

Laws: Now, you'd also be doing assembly. You did in-house assembly for a while, then you probably went with an overseas assembly contract. Or did you set up your own line overseas?

Hollins: Well, we certainly started off-- we had a small hermetic line making military products that we had in-house that I set up, but the volume material was all done with subcontractors. We had two main subcontractors. We had one in Korea. I think it was Anam. And we had one in Ipoh, Malaysia. I think their name was Carsem. And so they built all of our volume stuff, initially.

The company eventually-- when it got bigger, after I left-- did set up their own plants. Actually, they started off by setting up a plant in Singapore for test and finish and also design work. They set up a design lab, which the Singapore government almost made it mandatory that you do that to get permission to go in. They learn fast. But they eventually set up their own assembly line in Penang.

Laws: Were you overseas for the subcontractors?

Hollins: I made a number of trips overseas, yeah. If there were problems, I'd go over. And the same thing with National-- I made a number of trips over to Singapore, mostly. And also, they had some other subs I would visit. National also had a subcontractor in Tijuana, of all places, making TO-3s for us, so I made trips down there too.

Laws: What kind of problems were there that you personally would have to go overseas to help fix?

Hollins: They were usually die-related problems, and I can give you one classic example in National Semiconductor. We were getting-- these are back in the days when you communicate with telexes. We were getting reports back. And typically, our yield at second op-- so this would be the first visual inspection in the assembly line. They look at all of the dice individually, and then they pass or reject, and then they pass them on to be bonded and put in a package. We called it second optical. The yield there was typically low 90s-- 90, 91, 92. And we'd have a little graph showing it like this.

And then, just overnight, bang-- went down to 50%, 60%. And we spent the next two or three days trying to find out what the hell was going on via telex. Impossible. You'd ask the question, and you'd get the wrong answer. They wouldn't answer the question we asked-- not deliberately. It was just communication problems, and the communication means didn't lend itself well.

And so Diller told me, hey, get on a plane. Get in a plane tonight kind of thing. I got there the next day, and what I found was that there were a couple of different paragraphs for inspection criteria. One of them was for the damaged metallization or missing metallization. So for example, if we had a metal interconnect line-- might be half a mil wide-- you are allowed to have some of it missing and still pass it. Perhaps up to 25% of the width could be missing but still a pass. Or if it got smudged or the metal was sort of damaged-- same thing.

There was another category, another criteria in the spec, which said any signs of corrosion-- absolute reject. So what happened was that somebody-- it was actually a QA engineer from National had gone over to Singapore, and he had been looking at the dice, and he saw these little marks on the metallization, and they were actually caused by - the die were transferred -- transported in a vial, and they were all poured into this vial, and they're all next to each other, knocking each other. This is before we had passivation over them.

And so when they looked at them in second optical, there's some damage on the metallization. He looked at that, and he decided that that was corrosion. He was quite wrong. And so immediately, the yields were bang. The slightest trace of any missing metal, damaged metal, was out of there, which is half of the die. So I was able to fix that within hours. Just retrain the operators.

Laws: Today, of course, they'd send a photograph, and you'd know 10 minutes later what the problem was.

Hollins: Exactly, yeah.

Laws: Trying to transcribe that from a different culture and a different language via telex was quite challenging.

Hollins: Yeah, they were interesting days.

Laws: Other interesting people that you worked with at Linear? Was Clive Davis-- was he--

Hollins: Yeah, Clive came from National, like we did. I don't know if you remember, but I mentioned a guy called George Rutland took over the advanced linear line after Widlar and Talbert left. George hired Clive as his process engineering manager. That's where he started. And then, subsequently, he became the product line manager at the Standard Linear group.

Clive had a tremendous amount of experience, not only processing, but he also went to Singapore for a while, so he had the whole spectrum of manufacturing experience. And he wanted to join us, and so he was brought in as a vice-president of QA&R, which was a different job for Clive, but it was a good way for Bob to bring in a bright guy for the benefit of our company. And Clive, actually, eventually became president of Linear.

Laws: Did you have much interaction with the gurus, the design people that became quite famous as a result of the advertisement that Linear ran?

Hollins: Well, yeah. I had a lot of interaction with them, yeah, a tremendous amount. I mean, there's obviously the process interaction, whenever they needed help with processes, they would come to me. They'd go to Wadie or me, or both.

But the other side of that, which explains why a designer respects a good process guy, is that when the designers would put the new products through the line for the first time. It'd go through as an engineering run, never seen before by the designer. The designer's waiting with bated breath for his first run to come out so he can look at it.

Sometimes, it took a long time. It would get bogged down because of production pressures. Production guys are always told engineering runs first, but when push came to shove and they had to meet a schedule, then the engineering run would sit and wait and get bogged down, and they would come running to us, basically. Dobby would come running to me to free up the run. So I was his go-to guy for that.

So I interfaced in process support and also on solving reliability problems. Whenever we had a problem-- parts coming in from the field, say-- we'd sit down with the designer, and we'd do failure analysis on it and decide, is it something that can be fixed with a mask? Is it a layout problem and all that, or is it a process problem? [So there's a lot of interaction.] There's also interaction too on checking mask sets, that kind of thing.

Laws: Were you involved in other aspects of the company? Strategic direction, which markets you should be in or not be in?

Hollins: Well, I mean, I was involved in strategic decision. I was at that level, just below Bob, where I sat in on a lot of these meetings. But frankly, it was the design people who set the product strategic direction. Bob started off setting the basic, fundamental strategic direction for the company, and that was very simple. We will be [a] high performance company, only in the high performance segment, and we'd never do anything else. And Bob made sure that that happened-- stick to our knitting.

We did a good job of that, unlike a lot of other companies. We never got deterred from the path. As far as choosing products, that was the designers working with the customers. A lot of customer feedback-- they'd like us to do this. They'd like us to do that.

And also, we had a very, very strong FAE group at Linear. These are the field application engineers who would go out and help customers design products into their systems. So they had great visibility of the customer's system, and they would ask them, do you need anything else? They'd get a lot of feedback coming from that direction.

Laws: So what was the biggest challenge you faced during your time at Linear?

Hollins: Well, the biggest challenge for me, my side-- manufacturing-- was making sure that we didn't run out of capacity in any of the operations. And that became challenging at times. I can give one example, which is probably the most painful example for me during that period, was that in the test area, we would estimate how many testers we would need based on some assumptions. And it all had to do with the test time of each of the products. With Linear products, some of them were tested in milliseconds, others in seconds, so huge variety in test time, depending on the device.

And so what we had to do when we projected how many testers that we needed, we'd have to take some kind of an average and make our assumptions [from that]. And then we'd add on a safety factor, and that worked well for some years. But then, we ran into one particular period, where the product mix changed. And so if you've made assumptions-- how many of the slow test products there are going to be and how many fast-- if that mix changes, the assumption goes awry. That's exactly what happened.

So all of a sudden, we were being asked to build more products that took a long time to test, and all [of] a sudden, we ran out of test capacity. And it took several months to get out of that because you couldn't just call up LTX or Teradyne and say send me another tester. Typically, it would take them months.

Laws: Long lead times.

Hollins: Long lead time-- months to fill the order. And so that was difficult, and we had customers calling in, calling Swanson. When are we getting our new parts? Bob would come in. He would shout at me, and so on and so forth. So I'd say making sure that we always had enough capacity was probably my biggest challenge.

Laws: How much of the time was this kind of stress, Brian? Was it a lot of the time, some of the time?

Hollins: Manufacturing is always stressful, and I personally found it particularly stressful on just my physiology. In fact, that's the reason why I retired early, is that the company was doing great. I was doing a good job. We had that one time when we fell behind.

But after 20 years or more of having to meet deadlines on a monthly and sometimes weekly basis, I just personally found that very wearing. And I was in the fortunate position of being able to afford to take a break, so I decided to step back, step out of the industry, and retire for a while. And actually, when I did it, I fully intended to go back in some capacity somewhere, but it turned [out that] I enjoyed retirement so much that it never happened.

Laws: Typically, around how many hours a week were you working during the peak times at Linear?

Hollins: It wasn't ridiculous. It wasn't 80 hours like people seem to do these days. But there were long work days, and I didn't get there especially early because I'm not an early person. But I'd be getting home 7 o'clock, 7:30, 8 o'clock sometimes. And I didn't think that was a big deal, but I did actually once-- I did once read a report that my daughter wrote in college about her childhood in which she mentioned how she wished she saw her dad more often. So maybe I spent more time there than I thought.

Laws: You had two children?

Hollins: We have two girls, yeah, and we now have five grandkids.

Laws: Wow. Did you get to spend many weekends with the girls?

Hollins: There were occasions when I had to go in to address problems on weekends, but generally speaking, it was a five-day work week for me.

Laws: Did you have time for any recreational activities during this period?

Hollins: The one thing I did was run. I was a jogger, and a serious jogger. I ran marathons. I ran my first marathon when I was just under 40, actually, so that would be 1980. So that would be just shortly before I came to Linear.

But before that, I'd been running anyway, building up to the marathon. So throughout my National years and throughout the Linear years, I did a lot of running. I was running up to 70 miles a week when I was training for the marathons. And I actually find that to be very therapeutic. Non-runners don't understand that. I would go out for a 12-mile run every day for two or three days. Then I'd take a little bit of a break. How can you run 12 miles and feel relaxed?

Laws: You feel rested after that.

Hollins: I did because I was so well trained. You hear about something called runner's high? It really did exist. I could-- my mind shut down when I ran. I was in a complete state of relaxation. Maybe that's why I was doing it so much.

Laws: Probably.

Hollins: I needed it.

Laws: That's a way of relieving those stresses. So you retired around 1990 or so.

Hollins: Yeah. Well, actually, I think I retired as an employee in '89, but then, after a few months, Bob called me up and asked me to come back and help out with a project that they were just starting to set up, the second fab area. And when we built the building, we had sized it so that we could put two fab areas side by side.

During my tenure, the first fab area was just-- pretty well almost reached capacity. And so they were setting up the fab area, and he wanted me to come in and help with the initial stages of that, planning the facilitization of that, make sure that we could get everything in the space that I had forecasted years before was needed. And it turns out that we did. So I spent a few months on that project, and so it was 1990 when I stopped working for Linear for the last time-- quite a while ago.

Laws: Nearly 25 years.

Hollins: Right.

Laws: So what have you been doing for the last 25 years, Brian?

Hollins: I've been enjoying myself.

Laws: Good for you.

Hollins: Very active retirement.

Laws: Any particular hobbies?

Hollins: One on the things that I did was winemaking. I live up in Los Altos Hills, and I put in a-- it's a private vineyard. We don't sell the wine commercially, but I put in a vineyard. I built a wine cellar. My wife, Rene, is the vineyard manager. She does all of the pruning and canopy management, and she looks after the plants. She has a green thumb. And I did all of the cellar work. I was the winemaker.

Laws: The process engineering background probably helped there.

Hollins: Perfect. I mean, what better background? Winemaking is processing. So we make three different kinds of wines-- Chardonnay, Merlot, and Cabernet Franc. And they're very, very good, even if I say so myself. And we've been doing that for 20 years. So that keeps us busy.

And then, the other thing we do, which keeps us busy, is for the last 15 years, we've owned an apartment in San Francisco, and we actually commute weekly. We spend midweek in the city and long weekends down here. And so when we're in the city, we go mostly to art and supporting the arts. We go to ballet. We love the ballet. We're subscribers and patrons there. Also the opera-- Rene goes to ACT. I am on the board of San Francisco Jazz. That keeps me busy.

Laws: That's a jazz festival?

Hollins: No. The San Francisco Jazz Organization-- they built a brand new, first ever facility and auditorium dedicated solely to jazz-- first freestanding building dedicated solely to jazz in the nation. And we built it in San Francisco just a couple of years ago. And so I helped them with that, and I was on the

facilities committee, and ended up spending quite a bit of time doing that. So there's always been lots of things to keep me busy. No regrets. None whatsoever.

Laws: So there's nothing you look back on and say, boy, if I'd made another decision, would that have come out better?

Hollins: No. But there is one thing I look back on and wish I would've done differently, not related to that. And that is that when I came over here, I had my bachelor's in England. I came over here. I spent four years taking morning classes in Santa Clara and took an MS double-E degree there, which I got in 1970. And I did-- it was in electronic design. I did it because I didn't really want to let go of design, although I never, ever needed it. So I spent four years. I got a degree that I never, ever used. That was kind of a total waste of time.

What I should have done was taken an MBA degree, and that would have helped me because I was promoted very, very quickly through the ranks at National, and MBA background probably would have helped.

Laws: Do you think it might have helped some of the challenges you faced?

Hollins: Yeah. But you know, I can't think of a wrong decision that caused any major problems or even minor problems. I think my career went very smoothly, fortunately, and I was surrounded by these great guys [--]that helped a lot.

Laws: Any other names that come to mind that you felt really made a difference in your career or your outlook on it?

Hollins: I've mentioned Wadie Khadder. I've mentioned--

Laws: Maurice, you mentioned.

Hollins: Maurice Chidlow. Pierre [Lamond] was quite an influence too. It was a pleasure working under Pierre. He was very technically oriented, and so he was a kind of guy who could make quick decisions and that certainly helped a lot.

Laws: Good. Anything else you'd like to add to the end of our discussion here? We’re coming up for two hours.

Hollins: I don't think so. I think that's been pretty thorough.

Laws: Covered a lot of ground, both in years and in miles between here and-- do you get back to England at all? Do you still have relatives or family back there?

Hollins: Yeah. My wife still has lots of relatives in Scotland. She's from Edinburgh. We go there. Usually, when we go back to Britain, we go to Scotland. My parents have died, and my siblings are off in other places-- I have a brother in Zimbabwe. I still have a sister who lives here in Sunnyvale, so I see her all the time. But not much family in England, so we usually go to Scotland, but we go every couple of years.

Laws: How different would life have been if you had stayed in England? I go through that process myself sometimes.

Hollins: Absolutely. I can't even begin to imagine.

Laws: No, I can't. We had just wonderful timing,

Hollins: It was all because I was looking for a job in Germany to learn German.

Laws: Well, thank you, Brian. I appreciate the time you spent with us.

Hollins: OK, I enjoyed it.

Laws: Thank you.

Hollins: Take care.

END OF INTERVIEW

